

SCIENCE

FRIDAY, JULY 13, 1888.

NO SCIENTIFIC REPORT published by the government this year has been more important than that just made by Dr. J. J. Kinyown, assistant surgeon in the Marine Hospital Service, upon the germicidal powers of the different methods of disinfection practised under the direction of the Louisiana Board of Health at the quarantine station below New Orleans. The report is important, not only because it shows the degree of protection against the importation of infectious diseases through the important port of New Orleans; but also, since the methods of disinfection practised at other quarantine stations are similar to those in use there, the experiments show approximately the efficacy of each mode of disinfection, and suggest changes that should be made in their use. The three methods of disinfection tested were by the use of bichloride-of-mercury solution, the application of dry and moist heat, and fumigation with sulphur dioxide. Dr. Kinyown finds the first of these methods defective, because of the difficulty of getting the disinfecting-agent into cracks and corners, carpets, rubber goods, the under sides of decks, and into lockers, etc. He discovered in all these localities and articles that the micro-organisms existing before the disinfection had not been destroyed, and he found them as plentiful on the floor of the forecabin of one ship, that was exceptionally filthy, after it had been drenched with bichloride of mercury for an hour, as before. Dr. Kinyown recommends, that, in order to make this mode of disinfection more effectual, the bichloride of mercury be applied with a spray produced by a connection with a steam-boiler, and that it be applied after fumigation by sulphur. The results from the application of dry and moist heat were the most satisfactory of all. Cultivations of various disease-germs exposed to a dry heat of 80° C., and afterwards to steam at a temperature of 100° C., were, with few exceptions, destroyed. Dr. Kinyown thinks, that, in order to secure absolute protection, the heat should be made greater and the time of exposure increased. In eleven experiments seventy-four disease-germs were placed in vessels among articles to be disinfected by the use of sulphur dioxide, but only sixteen of the whole were destroyed, or less than twenty-two per cent. Dr. Kinyown has very little to say about this method of alleged disinfection, except to recommend that the sulphurous fumes be applied in larger quantities, and confined in the compartments to be disinfected a longer time. But he reports his experiments in full, and lets them speak for themselves. The net result of these tests is to show that some disease-germs escape even when the most effectual modes of disinfection practised at quarantine below New Orleans are resorted to, and that less than one-fourth of them are killed when the least effective method is used. We assume that quarantine and city health officers everywhere will profit by the suggestions of this report, and that the public will be better protected in the future than in the past.

AT THE RECENT MEETING of the Massachusetts Assembly of the Agassiz Association in Boston, Prof. W. O. Crosby called attention to the fact that Mr. Harlan H. Ballard, the president of the association, in the 'Three Kingdoms' and elsewhere, has rightly emphasized the importance of studying the local natural history, and explained that this is especially desirable for the department of geology and mineralogy, since the rocks and minerals are in most

parts of the country, and especially in New England, much more localized than the fauna and flora. Thus, while the animals and plants must always change gradually from place to place, and may be nearly the same for an entire State, the geological features, the rocks and minerals, change very abruptly, and sometimes completely, as we pass from one formation to another; so that adjoining towns and neighborhoods are sometimes as strongly contrasted in their mineralogy and geology as the most distant parts of the earth. It will be readily seen that where this is true it is particularly desirable that each chapter should give attention chiefly to its own field; and interesting results may be expected from the presentation and comparison, at these annual meetings, of the work done in the different parts of the State. In this way each chapter will gain not only a valuable training in observation, but also that real and satisfactory knowledge of the local geology which can be obtained only through original study; while through the interchange of results and ideas the field is broadened, and the methods of work gradually improved. Professor Crosby spoke further as follows: "During all the time that I have been conducting the lessons in elementary and determinative mineralogy, I have felt that we should realize more fully the ideal plan of work for the Agassiz Association, if I could co-operate with members and chapters in the study of their local geology and mineralogy. Of course, it would be preposterous for any one to propose to do this for the entire organization. Not to mention other difficulties, such as the time required, it would be out of the question for any one specialist to have that detailed knowledge of the geology of the entire United States which would be required for the successful operation of such a plan. The organization of the Massachusetts Assembly has, however, suggested to me that I might, perhaps, be of some real assistance in this direction to the Massachusetts chapters. But, in offering to assist those who are really in earnest, I have no thought, of course, of pre-empting the field, or excluding other geologists. I simply desire to say that I, for one, shall be glad, so far as my time and ability will permit, to render such assistance as may be needed. I can help you sometimes in the determination of specimens; although it is to be hoped, for your own sakes, that you will heed Mr. Ballard's advice to exhaust your own resources before applying for such aid. I can, perhaps, offer useful suggestions as to the best plans for work in particular localities, and may be able to put you in the way of getting the necessary maps, etc., for the representation of your results. Lastly, though I can imagine that Professor Hyatt would advise me to proceed very slowly here, I can often aid you in finding what has been published on the geology and mineralogy of the different sections of the State. I shall, however, be very reluctant to do any thing in this direction in advance of good, original work in the field. The literature of your field would at first, in most cases, be only a hinderance to good work. It is to be hoped that every year you will bring your best results to these meetings, not merely brief reports of what you have worked at, but the work itself. Your principal reward will, of course, be the training and knowledge gained, and the satisfaction of having done good work. But it would be very strange indeed if such an exhibit of a year's results did not reveal something new to science, and worthy of publication; and this is another direction in which we should be glad to lend a hand." No chapter in Massachusetts can afford to neglect so rare an opportunity as Professor Crosby offers. Will not geologists in other States take a hint from this wise and generous method of encouraging this important branch of study in a practical manner?

METHODS OF DISINFECTION.

At the request of the State Board of Health of Louisiana, that a test be made of the efficiency of the modes of disinfection employed by that board, Dr. Hamilton, surgeon-general of the Marine Hospital Service, detailed Assistant Surgeon J. J. Kinyown, last spring, to make the investigation. Dr. Kinyown's full report is published in the *Weekly Abstract* for June 29, and is so interesting and important that copious extracts from it are given below.

After describing the quarantine station and hospital below New Orleans, at which he arrived May 6, Dr. Kinyown makes full quotations from the brochure of Dr. Joseph Holt, ex-president of the Louisiana Board of Health, entitled 'The Quarantine System of Louisiana: Methods of Disinfection Practised,' to show the manner in which *it is claimed* that the germs of disease are destroyed in the baggage of passengers and crew of vessels, the cabin, deck, hold, and cargo. It is unnecessary even to make an abstract of these passages, since the modes of disinfection used are sufficiently indicated by Dr. Kinyown's own remarks and the reports of the experiments he conducted. It is sufficient to say that three methods of disinfection are described, — that by the application of bichloride of mercury, fumigation with sulphurous oxide, and by applications of dry and moist heat.

"Testing the efficacy of the methods practised and materials used in the disinfection of ships, cargo, and baggage," etc., says Dr. Kinyown, "was with special reference to the germicidal powers for which it is claimed.

"Accordingly, before leaving New York, a large number of cultivation-tubes were prepared, containing blood-serum, peptone gelatine, agar-agar, and rags. A large number of these were inoculated from pure cultivations of the micro-organisms here mentioned; viz., spirillum cholerae Asiaticæ, spirillum Finkler-Prior, bacillus anthracis, bacillus typhi abdominalis, bacillus coli communis (Hueppe), bacillus murisepeticus, bacillus pneumoniae (Friedlander), bacterium of yellow-fever (Finlay), staphylococcus pyogenes albus, staphylococcus pyogenes aureus, streptococcus erysip-elatus.

"Several of the series of above-named micro-organisms were obtained of Dr. T. M. Prudden; also one specimen of the micro-organism claimed to be the cause of yellow-fever, by Dr. Finlay of Havana, Cuba; another of the same organism was furnished by Dr. S. T. Armstrong, who had only a few days prior to my departure received it from Dr. Finlay.

"Whether the organism referred to is the cause of yellow-fever, we leave for others to confirm or disprove.

"In carrying out the following series of experiments, it was intended to show whether the process of disinfection applied to such vessels was sufficient to destroy the growth of these micro-organisms; and in but few instances was the process varied or the time lengthened from that which is practised from opening of the quarantine season to June 1, when the time is lengthened to five days. It was also for the purpose of deciding whether the time imposed on vessels prior to June 1 was sufficient for the prevention of epidemic disease.

"In carrying out these experiments, several classes were conducted at the same time, and, to have them correspond with the description of the machinery, etc., the same order will be followed.

"Since the opening of the season, vessels engaged in the fruit-trade, and plying between ports subject to quarantine, are not subjected to the same treatment as others. Should they have any passengers aboard who have with them any baggage or articles of clothing save what they wear, they are compelled to stop at the upper station, where the baggage of passengers, crew, ship's linen, etc., are subjected to the steaming process, while the cabin and deck are washed down with bichloride solution.

"If no baggage is aboard, they are given pratique to the city, where the cargo is discharged, and vessel cleansed by washing the deck and burning sulphur in the hold. The quantity of sulphur used was not learned.

"Whenever practicable, all the surfaces inside the hold of the vessel and between-decks are wetted by a simple $\frac{1}{4}$ -inch hose with nozzle, the rose being dispensed with, as it is claimed that there can be a more thorough wetting accomplished than by its use.

This is invariably done before the vessel is treated to sulphur dioxide, in order to delay it as little as possible.

"The flat surfaces of the decks are thoroughly washed with a rose sprinkler, but around among the corners, hatches, or perchance hogsheads of sugar that are sometimes on deck, the process is defective, because a great many places are not reached. The same can be said of the disinfection of the cabin, lockers, etc.: only a partial disinfection is accomplished; for, to wet all surfaces, with the present arrangements it would be necessary to almost submerge them with the solution. The carpets, rugs, rubber and leather goods, trunks, and valises are sprinkled with the same bichloride solution.

"Several experiments were made upon the goods, clothing, and surfaces thus treated; and it was found that the solution did not cover all the surface, for portions of carpets, scrapings from floor and under side of the fore-castle, deck, etc., when placed upon sterilized nutrient media, showed evidences of germ-development. No apparent difference could be noticed between portions removed from the floor of the fore-castle after being saturated for one hour with the bichloride, and other portions of the same that had not been reached by the solution. The last can be explained by the fact that the fore-castle was in an extremely filthy condition, and, there being such an abundance of organic matter, the bichloride was rendered inert.

"For the general application of this solution to the ship, especially to cabin, carpets, etc., we suggested that a spraying apparatus be substituted, made by leading a rubber hose from the boiler of the tug, and connecting it with the supply-pipe of the bichloride solution in such a manner as to make a 'Richardson's spray-producer' on a large scale, so that by its use all surfaces, cracks, etc., can be thoroughly and evenly wetted.

"Former experience teaches that placing dirty and greasy clothing in the heating-chamber is not a safe procedure with the present apparatus, for to them have been traced the cause of fires breaking out during the steaming process. They are now left on deck and sprinkled with bichloride of mercury, in the following manner: One attendant stands ready with hose in hand, while another places the clothing to be thoroughly wetted down on the deck, turning them over from time to time, while the other plays a stream of bichloride upon them.

"The car upon which the clothing, bedding, goods, etc., is placed for the purpose of transporting them to the steam-heating chamber is not disinfected before the goods are placed upon it to be taken back to the ship."

Seven tables are given for the purpose of showing the variations of temperature obtained in the heating-chamber, and Dr. Kinyown then proceeds to give detailed reports of the experiments he made. The first series was for testing the applications of dry and moist heat. He says:—

"I was informed by Dr. Aby that his instructions from the board of health were to the effect that clothing, bedding, etc., after being placed within the chamber, should be raised to a temperature of 85° C., after which the steam should be turned on, and kept for twenty minutes after the thermometer indicates 100° C. This manner renders fire less imminent. The time of exposure of micro-organisms to the heating process was not varied from the prescribed rules, save in two instances.

"Cultivations of micro-organisms on various substances were placed, in each of the following experiments, in positions where the minimum heat was to be expected.

"EXPERIMENT NO. 1. — Cultivation-tubes of peptone agar-agar inoculated with spirillum cholerae Asiaticæ, bacillus anthracis, bacillus typhi abdominalis, bacillus coli communis, bacterium of yellow-fever (?), were placed in a wire basket and hung in the compartment most distant from the boiler, and upon which but little clothing was hung. In sixteen minutes the temperature (dry heat) reached 79.4°, when steam was turned on and kept twenty minutes, cultivations removed, and inoculations made therefrom, the temperature being ascertained by placing a self-registering thermometer upon the surface of agar-agar within the cultivation-tubes. Repeated examinations show all growths to have been killed.

"EXPERIMENT NO. 2. — Cultivations of spirillum cholerae Asi-

aticæ on blood-serum, bacillus anthracis on agar-agar, bacillus typhi abdominalis on agar-agar, bacillus coli communis on agar-agar, bacillus pneumoniae on agar-agar, bacterium yellow-fever (?) on agar-agar, staphylococcus pyogenes albus on blood-serum, staphylococcus pyogenes aureus on blood-serum, were suspended in among blankets and mattresses in a compartment near the boiler. A quarantine thermometer registered 88.8° dry heat in central chamber. Steam turned on, and kept forty-three minutes. Temperature among blankets fell to 82.5°. Inoculations made from these cultivations into peptone gelatine showed the bacillus anthracis and bacterium yellow-fever alive: all others were dead. The temperature was taken on the outside of the cultivation-tubes.

"EXPERIMENT NO. 3. — Chamber filled with goods, consisting chiefly of bedding and clothing of the crew. The articles were not hung closely together, as the chamber was filled to only three-quarters of its capacity. Cultivations of spirillum cholerae Asiaticæ, spirillum Finkler-Prior, bacillus anthracis, bacillus pneumoniae, bacillus typhi abdominalis, bacillus coli communis, bacterium yellow-fever (?), staphylococcus pyogenes albus, staphylococcus pyogenes aureus, were placed in a basket and arranged upon and between mattresses. Thermometers being placed among cultivations, temperature registered 85.5° C. dry heat in centre chamber. Steam turned on, and allowed to remain twenty-seven minutes. All micro-organisms dead except those of bacillus anthracis and bacterium yellow-fever. Thermometer among cultivations indicated 95.5° C.

"EXPERIMENT NO. 4. — Chamber partially filled, compartment containing principally the mattresses and clothing of the crew. A hair mattress was opened, and tubes containing cultivations of spirillum cholerae Asiaticæ, spirillum Finkler-Prior, bacillus anthracis, bacillus typhi abdominalis, bacillus coli communis, bacterium yellow-fever, bacillus murissepticus, staphylococcus pyogenes albus, staphylococcus pyogenes aureus, were placed within, and exposed to moist heat for twenty-five minutes. A self-registering thermometer placed among tubes indicated 75°. Examination of growths showed those of bacillus anthracis, bacillus murissepticus, and bacterium yellow-fever to be alive: all others were killed.

"EXPERIMENT NO. 5. — Chamber well charged with goods. A series of cultivation-tubes containing rags (both cotton and woolen) that had been inoculated with bacillus anthracis, bacillus typhi abdominalis, bacillus pneumoniae, staphylococcus pyogenes albus, staphylococcus pyogenes aureus, were placed in among mattresses and blankets, and exposed for twenty minutes to moist heat. Temperature indicated, 62.5° C. Examination showed all growths dead save that of anthrax.

"EXPERIMENT NO. 6. — Clothing and bedding of steamship 'Saturnina,' from Cuba to New Orleans, placed in heating-chamber; all compartments filled. Owing to the uncleanness of the crew's bedding, we suggested that a longer time be given in the steaming process. Cultivations on agar-agar of spirillum cholerae Asiaticæ, spirillum Finkler-Prior, bacillus anthracis, bacillus typhi abdominalis, bacillus pneumoniae, bacillus coli communis, staphylococcus pyogenes albus, staphylococcus pyogenes aureus, were placed in the compartment, arranged on mattresses, and surrounded by pillows. Temperature of middle chamber (quarantine thermometer), 76.6° C. Left for fifty-five minutes. Thermometer among cultivations indicated 67°. Inoculations show all killed except bacillus coli communis and bacillus anthracis.

"EXPERIMENT NO. 7. — Chamber was lightly charged, several panels in each compartment being empty. Cultivations made upon rags of the following: spirillum cholerae Asiaticæ, bacillus typhi abdominalis, bacterium yellow-fever, staphylococcus pyogenes albus, staphylococcus pyogenes aureus. These were suspended among clothing, chiefly underwear, and allowed to remain forty minutes. A thermometer placed in a tube containing similar media registered 99°. Inoculations from the tubes show that all have been killed except the bacterium of yellow-fever.

"EXPERIMENT NO. 8. — Chamber filled with goods, — bedding and clothing. Cultivations of spirillum cholerae Asiaticæ, bacillus anthracis, bacillus typhi abdominalis, bacillus coli communis, bacterium yellow-fever, staphylococcus pyogenes albus, were placed in heating-chamber, in its centre, arranged upon blankets and clothing. These were subjected to moist heat for forty minutes. Tem-

perature indicated near cultivations was 69°. The bacillus anthracis, bacillus typhi abdominalis, bacillus coli communis, and staphylococcus pyogenes albus were found to be alive.

"The quantity of sulphur consumed in the fumigation of each vessel is from 100 to 400 pounds, according to the size of the vessel. Those arriving at quarantine during our stay at the station varied from 100 to 2,000 tons burden. About 100 pounds of sulphur are consumed in an hour, and form about 1,170 cubic feet of sulphur dioxide. If, as is claimed, 180,000 cubic feet of air per hour be driven into the hold or compartment of a vessel, the strength of the gas would be approximately .6 per cent.

"That that quantity of air is not driven into the hold is proven by the fact that in quite a number of volumetric analyses, made on various vessels at the close of fumigation (for the purpose of determining the quantity of sulphur dioxide present), it was shown that there are from 2 to 6 per cent to the 100 pounds of sulphur, the capacity of the compartments being about the same, viz., 20,000 cubic feet. This does not represent the full amount of the gas generated, for in all vessels there is constantly present a certain amount of moisture, which absorbs the gas.

"In the generation of the sulphur dioxide there is formed in the 'battery' a certain amount of nitrous oxide, and, the gas being quite hot (130°) as it enters the vessel, every factor is present for the rapid production of sulphuric acid. The greatest percentage of gas was found in holds containing coffee, still less in sugar, and least in those vessels that had been treated with the bichloride solution previous to fumigation. In these the percentage was notably diminished (2 per cent), the gas being absorbed by the wetted surfaces, also uniting with the mercuric salt, forming a compound which impairs germicidal power of both, and destroys penetrating properties of the gas.

"We were informed that it was the custom formerly to put the exhaust-fan in operation for an hour before, driving pure air into the hold, thus aerating the vessel and cargo before fumigation was commenced. This was not put in practice during our stay. Vessels hailing from ports known to be infected are treated to a larger quantity of gas, 200 pounds or more of sulphur being used to each compartment.

"In testing the germicidal power of the fumigating process it was for determining whether the short time of detention practised prior to June 1 was of sufficient duration to insure complete disinfection of vessel and cargo.

"Where the compartments are empty or communicating with the engine-room or chain-locker, the hatches are not sealed by the customs authorities, and there is no assurance that the sulphur fumes remain longer than a short time after the disinfection is finished.

"It was noticed in several instances where the forward hatch communicated with the chain-locker or engine-room, that the hatches were removed immediately after fumigation, and a wind-sail put in place for the purpose of driving out the fumes, so as to enable the vessel to leave for New Orleans as soon as possible.

"Vessels having their hatches sealed are insured of at least fifteen hours' disinfection. The forecastle, after being thoroughly wetted with bichloride solution, is treated to the 'pot plan,' the longest period of time being three hours, after which it was immediately permitted to be thrown open by the crew. The following experiments were made: —

"EXPERIMENT NO. 1. — Spanish bark 'Pedro,' from Havana to New Orleans. Thoroughly wetted down with bichloride solution. A basket containing cultivations on agar-agar that had been inoculated fifteen days previously with spirillum Finkler-Prior, bacillus anthracis, bacillus typhi abdominalis, bacillus coli communis, bacterium yellow-fever, was placed about sixty feet from the hatch, where the fumigating-pipe enters. The cotton plugs were removed from the test-tubes. These were left for a period of ninety minutes, the time occupied in the fumigation. One hundred and fifty pounds of sulphur were used. Inoculations made from time to time from these tubes show that all the growths were not influenced by the exposure.

"EXPERIMENT NO. 2, SO₂. — Steamship 'Morgan.' Rear hold compartment filled with sugar in sacks. A basket containing cultivations prepared for exposure was placed in the hold about six-

teen feet distant from the hose leading into the compartment; tubes containing spirillum Finkler-Prior, bacillus anthracis, bacillus pneumoniae, bacillus murisepticus, bacterium yellow-fever (?), staphylococcus pyogenes albus, staphylococcus pyogenes aureus. Time of exposure, two hours and twenty minutes. One hundred and fifty pounds of sulphur used. Owing to the character of cargo, no bichloride solution was used. Inoculations made from growth of each micro-organism show no effect upon them.

"EXPERIMENT NO. 3, SO₂. — Two baskets were prepared for placing in the forward hold of steamship 'Morgan'; capacity, 101 tons; cargo of sugar in bags; basket No. 1 containing cultivations of spirillum cholerae Asiaticae on blood-serum and rags, bacillus coli communis on agar-agar, streptococcus erysipelatus on blood-serum; basket No. 2, spirillum Finkler-Prior, bacillus anthracis, bacillus coli communis, bacillus pneumoniae, bacterium yellow-fever (?).

"Basket No. 1 placed fifteen feet from pipe; basket No. 2, thirty feet from pipe. Cultivations exposed for one hour and twenty minutes; fumigation lasted one hour. About 100 pounds of sulphur used. Cultivations had to be removed, as the vessel was ready to leave the dock; forward hatch was not sealed. All cultivations alive; no inhibitory effect noted.

"EXPERIMENT NO. 4. — Steamship 'Floridian,' from Colon to New Orleans, having but little freight; several compartments empty. Cultivations of spirillum cholerae Asiaticae on blood-serum, spirillum Finkler-Prior on blood-serum, bacillus anthracis on agar-agar, bacillus typhi abdominalis on agar-agar, bacillus murisepticus on blood-serum, bacillus cholera nostras on agar-agar, staphylococcus pyogenes albus on agar-agar, staphylococcus pyogenes aureus on agar-agar, were placed in forward compartment (empty). Compartment fumigated for two hours, and allowed to remain for eight hours and thirty minutes. Inoculations were made from time to time, and it was found that those of cholerae Asiaticae, Finkler-Prior, staphylococcus pyogenes alba and aureus, and bacillus murisepticus, were dead. No effect was noted in any way upon anthrax, typhoid, and cholera nostras.

"EXPERIMENT NO. 5. — Cultivations prepared by placing a small quantity of sterilized cotton in test-tubes, and moistening it with a small quantity of distilled water. The cotton was then infected with several growths of the following: spirillum cholerae Asiaticae, spirillum Finkler-Prior, bacillus anthracis, bacillus coli communis, bacterium yellow-fever (?), staphylococcus pyogenes albus, staphylococcus pyogenes aureus.

"These were placed in an empty compartment that had been thoroughly washed down with the bichloride solution. About 125 pounds of sulphur used. Volumetric examination of gas shows 8 per cent. Time cultivations were exposed, three hours and fifty minutes. Only that of cholerae Asiaticae was killed.

"EXPERIMENT NO. 6. — Cultivations on agar-agar, made only twenty-four hours before, of spirillum cholerae Asiaticae (2), spirillum Finkler-Prior, bacillus anthracis, bacillus typhi abdominalis, bacillus coli communis, bacillus pneumoniae, bacterium yellow-fever (?), staphylococcus pyogenes albus, staphylococcus pyogenes aureus; also cultivations on cotton and woollen rags of spirillum Finkler-Prior, bacillus coli communis, bacillus pneumoniae, bacillus typhi abdominalis, bacillus murisepticus, staphylococcus pyogenes aureus, streptococcus erysipelatus.

"Both series were placed in the forward compartment of steamship 'Lizzie Henderson,' a small steamer plying between Tampa and New Orleans. After fumigation the hatch was battened down, and the cultivations left until the vessel arrived in New Orleans, when they were taken out and inoculations made therefrom into fresh agar-agar. Time of exposure, twenty-four hours. Of the growths upon agar-agar, those of bacillus pneumoniae, Finkler-Prior, and cholerae Asiaticae were killed. None of those on rags affected.

"EXPERIMENT NO. 7. — Cultivations made twenty-four hours before, upon the surface of agar-agar, of spirillum Finkler-Prior, spirillum cholerae Asiaticae, bacillus anthracis, bacillus typhi abdominalis, bacillus coli communis, bacillus pneumoniae, bacterium yellow-fever (?), placed in forward hold of steamship 'Hutchinson,' down under bags of sugar. Fumigation for one hour and twenty minutes; then hatch closed. Fifteen hours later, while proceeding

to the city, the hatch was thrown open; and nine hours thereafter, on arrival in New Orleans, the basket was removed. All germs found living.

"EXPERIMENT NO. 8. — Potato placed in large test-tubes, and inoculated with spirillum cholerae Asiaticae, spirillum Finkler-Prior, bacillus anthracis, bacillus typhi abdominalis, bacillus coli communis, bacillus pneumoniae, bacterium yellow-fever (?), staphylococcus pyogenes aureus.

"These were placed in a basket, and wrapped in an old mattress, which was lowered into an empty compartment of the steamship 'Saturnina.' Fumigated for two hours. 200 pounds of sulphur used. The mattress was taken out four hours after. All growths dead except anthrax, typhi abdominalis, staphylococcus pyogenes aureus, cholera nostras, and yellow-fever. Test-tubes containing agar-agar and gelatine show that the gas in the above-mentioned time penetrates to the depth of three-quarters of an inch. Percentage of gas, 6 per cent. Hatch sealed by customs-officer.

"EXPERIMENT NO. 9. — Recent cultivation on agar-agar, of spirillum cholerae Asiaticae, spirillum Finkler-Prior, bacillus anthracis, bacillus coli communis, bacterium yellow-fever (?), staphylococcus pyogenes albus, were placed in hold of bark 'Antonio Georgio,' in ballast, from Havana to New Orleans. Ballast and interior of hold well washed down with bichloride solution. Fumigation, an hour and a half. 150 pounds of sulphur used. Time of exposure, two hours. No effect on the organisms.

"EXPERIMENT NO. 10. — A basket containing surface cultivations on agar-agar, of spirillum cholerae Asiaticae, bacillus anthracis, bacillus typhi abdominalis, bacillus coli communis, bacillus murisepticus, staphylococcus pyogenes albus, bacterium yellow-fever, was placed in forward compartment of steamship 'Inventor,' down under bags of coffee, being well covered up. Fumigation lasted four hours. 275 pounds of sulphur consumed. Hatch was then closed for seven hours, when it became necessary, on account of the chain-locker communicating with the compartment, to open the hatch and place wind-sail in position, in order to drive out the gas, so that anchor could be raised. The basket was removed on arrival in New Orleans, twenty hours after, at which time the fumes were still quite strong. Examination showed all cultivations to be alive, though slight inhibitory effect was noticed.

"Cultivation-tubes containing agar-agar and gelatine that were exposed at the same time to SO₂ completely inhibited the growth of all micro-organisms tested.

"EXPERIMENT NO. 11. — Cultivations on agar-agar, of spirillum cholerae Asiaticae, bacillus anthracis, bacillus typhi abdominalis, bacillus murisepticus, staphylococcus pyogenes albus, placed in rear compartment of steamship 'Inventor,' at a point farthest from the entrance of SO₂. Cargo, sugar. Fumigation for four hours and thirty minutes. 300 pounds sulphur used; hatch then sealed. On arrival in New Orleans, twenty-two hours later, the hatch was opened and an attempt made to remove the basket, but the fumes of the gas were so strong that this could not be accomplished for two hours and a half. Examination of the cultivations showed that all micro-organisms were dead except that of anthrax.

"Cultivation-tubes containing agar-agar and gelatine showed the same inhibitory power as in the preceding experiment.

"EXPERIMENT NO. 12. — A litre of air was collected in sterilized vessels before and after the application of sulphur dioxide. Examination was made for the purpose of determining whether or not the gas exercised a germicidal effect on the micro-organisms of the air in the ship's hold.

"A series was collected that had been exposed one, two, four, and eight hours respectively, samples having been collected previous to application of the gas for the purpose of making control observations. None of the series showed diminution in number.

"EXPERIMENT NO. 13. — Cultivation-tubes containing peptonized agar-agar, gelatine, and rags, exposed for one, two, and four hours, show a decided inhibitory effect on all micro-organisms that were tested. Those exposed for six, eight, and twenty hours to sulphur dioxide killed all non-spore-bearing germs.

"It has been our intention to show by the foregoing observations upon the methods practised in carrying out the present system of quarantine at this station whether or not it is efficient; if not, to show its defects, and how remedied.

"In the evolution of such an establishment, the many difficulties that must have stood in the way of such an undertaking, due credit must be given to those gentlemen who formulated the theory and put in practical operation the present system of disinfection.

"From the series of observations made in determining the temperature of the chamber for the application of dry and moist heat, it is clearly shown that the time prescribed is entirely too short when the chamber is filled with goods; more especially is this noticed when the chamber is filled with such goods as blankets, mattresses, and cushions. Unless a longer period of time is given to each charge, it is certain that only a partial disinfection is accomplished.

"It was suggested to Drs. Wilkinson and Aby that the defects of the present style of steaming-apparatus could be best overcome by adopting the application of dry and moist heat under a pressure of from ten to twenty pounds. To accomplish this it would be necessary to have new machinery, — instead of the steaming-chamber now in use, to have constructed a large chamber of boiler-iron, capable of standing at least twenty-five pounds pressure to the square inch, and provided with one bulk-head door that could be properly secured to make it steam-tight, being provided with suitable appliances for ascertaining the temperature in any part of the chamber. In this manner the disinfection by steam and dry heat could be thoroughly accomplished, and much more speedily than at present. Lighter articles, such as clothing, etc., when not too much crowded, received sufficient heat to disinfect them.

"We are informed by the president of the board, Dr. Wilkinson, that the matter was laid before the health board, and it was by resolution decided to remove the present location of the quarantine station to a place farther down the river, in order that there could be complete isolation; and, guided by the result of the experiments undertaken, a heating-chamber capable of sustaining sufficient pressure from within will be erected, thus insuring an equal distribution of heat and the possibility of attaining and maintaining a much higher temperature than at present; also that an order would be given to the resident physician to the effect that the steaming-chamber should not be so heavily charged, and the time of exposure be extended to a sufficient limit to insure a proper degree of heat.

"It is believed that if, before the application of sulphur dioxide to the holds and cargoes of vessels, the holds be thoroughly aerated by means of the exhaust-fan and the use of a greater quantity of sulphur, confining the gas in the vessel, say, a period of not less than thirty-six hours, then the application of the bichloride solution to the hold and between-decks will accomplish a thorough disinfection of the surfaces of vessel and cargo.

"It is shown that in the short process of fumigation prior to June 1 the gas does not penetrate to any depth in such cargoes as coffee, sugar, etc. After June 1, the time of detention being five days, there is insured a thorough application of the gas in its greatest germicidal power.

"The following conclusions may be drawn:—

"1st, That the application of bichloride solution to interior of the cabin, carpets, rugs, trunks, valises, rubber and leather goods, should be made in such manner as to insure the moistening of all surfaces.

"2d, The chamber should not be charged to more than half its capacity, and the time lengthened to at least one hour.

"3d, That the time imposed on vessels that have undergone the fumigating process prior to June 1 should be longer, and the application of bichloride to the interior of the hold should be done after the gas has been confined at least thirty-six hours.

"4th, That the establishment of the present style of apparatus is a great stride in the right direction, and has demonstrated its feasibility and the correctness of the principles involved.

"The president, Dr. C. J. Wilkinson, asserts, that, whatever degree of heat has been obtained, it is certain that no case of yellow-fever has developed on any vessel that has been subjected to this process; a fact, however, which was not uncommon under previous methods."

It is announced that in October, 1889, the second triennial session of the International Congress of Hydrology and Climatology will be held in Paris.

PROTECTION OF BUILDINGS FROM LIGHTNING.

FROM the time that Franklin flew his kite at Philadelphia, and ascertained beyond cavil the true nature of lightning — from that time to the present, the protection of buildings and ships from its destructive agency has been mainly a matter of detail, and application of the laws of electricity so far as they were known.

For a long time the erection of lightning-conductors was opposed by the religious world as heretical and impious. But first in some Protestant provinces in Germany, and later in France and England, the use of the heretical rods gradually extended.

At some recent meetings of the London Society of Arts, Prof. Oliver J. Lodge has delivered a series of lectures on protection from lightning, in which he has summarized the prevailing opinions of scientific men.

The two main destructive aspects of a lightning-flash are (1) its disruptive, or expanding, or exploding violence; (2) its heat. The heating effect is more to be dreaded when the flash is slow and much resisted; the bursting effect, when conducted well, except at a few places. A noteworthy though obvious thing is, that the energy of the discharge must be got rid of somehow. The question is, how best to distribute it.

That conductors often fail is undeniable. It is customary to say they are not properly made, or that there was a faulty joint, or that there was a bad earth. A bad earth is the favorite excuse. A good earth is a good thing undoubtedly, and one cannot well have too much of it; but for a flash to leave a fine thick copper conductor on a tall chimney while still high up, and begin knocking holes in the brickwork in order to make use of the soot, or the smoke, or some bolts or other miserable conductors of that sort, because it is not satisfied with the moderate allowance of earth provided for it at the bottom, is evidence either of simple perverseness, or else of something more deep-seated and not yet properly called attention to.

If the earth is bad, the flash can show its displeasure when it gets there by tossing it about, and boring holes into it, and breaking water and gas mains; but at least it might leave the top and middle of the chimney alone, it might wait till it got to the badly conducting place before doing the damage. Yet it is notorious that on high chimneys a flash often refuses to follow a thoroughly good conductor more than a quarter or half way down, but takes every opportunity of jumping out of it and doing damage.

It may be said that the effect of the bad earth is to make the whole path so highly resisting that the discharge necessarily declines to take it. Well, if that were so, it need not have come into the conductor at all. It is supposed with one breath to strike the conductor, because it affords an easy path to earth; and with the next it is said to leave the conductor, because, after all, it finds it a bad one.

Besides, it need not be so very particular about a little resistance. It has already come through, say, half a mile of clear air: it might manage a few feet of dry soil. It strikes violently through the air, enters the conductor, and begins to go quietly. Why does it not continue to go quietly till it gets to the bottom of the good conductor, and then begin displaying its vigor by boring holes below, as it has done above? Why should one end have to be so persistently cocked up? Why not insist upon having not only a good 'earth,' but also a good 'sky'?

The old and amusing political controversy between knobs and points has disappeared. Points to the sky are recognized as correct; only Professor Lodge would advocate more of them, any number of them, rows of them, like barbed wire — not necessarily at all prominent — along ridges and eaves. For a point has not a very great discharging capacity. It takes several points to discharge readily all the electricity set in motion by a moderately sized Voss or Wimshurst machine: hence, if you want to neutralize a thunder-cloud, three points are not so effective as three thousand.

An earth is necessary, or you will have your foundations knocked about and your garden ploughed up. A good earth is desirable. A few tons of coke, with the conductor coiled up among it, is a well-known and satisfactory plan if the soil be permanently damp. A bag of salt might, perhaps, be buried with it to keep it damp throughout, or rain-water may be led there. Often, however, the most

violent thunder-storms occur after a spell of fine weather, and the soil is likely to be dry. It is best, therefore, to run your conductor pretty deep, and there make earth.

It is all very well to connect the conductors to water-mains if near; but, if they are far off or non-existent, it is no use; and in no case, in Professor Lodge's opinion, should they be used as sole earths, certainly not gas-mains. In dry weather they are not earthed at all well, and a strong charge may then surge up and down them, and light somebody else's gas in the most surprising way. It does not often happen, but it may happen in sandy soil after dry weather.

It is a superstition to place much reliance on the testing of conductors with a galvanometer and Wheatstone bridge. A galvanometer and Wheatstone bridge are powerless to answer many important questions. A Leclanché cell can no more point out what path lightning will take, than a trickle down a hillside will fix you the path of an avalanche. The one is turned aside by every trivial obstacle, and really chooses the line of least resistance; the other crashes through all obstacles, and practically makes its own path. A flash strikes a house at one corner, rushes apparently part way down the conductor, then flashes off sideways to a roof-gutter, sends forks down all the spouts, and knocks a lot of bricks out. Another branch bangs through a wall in order to run aimlessly along some bell-wires, and then out through a window-frame, and down a spade or something propped up against the wall, to earth. The lightning-tester comes with his galvanometer and Leclanché cell, and reports that the earth of the conductor has one hundred ohms resistance; and the accident is therefore accounted for. But how much resistance would he have found in the paths which the lightning seemed to choose in preference to the one hundred ohms? Something more like a million probably.

Something has been left out of consideration, and something very important too; and until that something is fully taken into account, no satisfactory and really undeniable security can be guaranteed. That something is inertia, — electrical inertia.

The word 'inertia' one uses as conveying a correct general notion of the behavior of an electric circuit to sudden electro-motive forces, — a behavior which is caused by the influence or induction which every portion of a circuit exerts on every other portion. Consider a conducting-rod as analyzed into a bundle of parallel wires or filaments, and let a current be suddenly started in all. The rising current in any one filament exerts an opposing force on all the others; and this self-generated opposition electro-motive force, due to induction between the different filaments of the conductor, exactly imitates the effects of ordinary inertia as observed in massive bodies submitted to sudden mechanical forces.

The term commonly employed to denote the electrical inertia-like effect is 'self-induction,' which is becoming gradually shortened to 'inductance.' Its original form when first dealt with by Sir William Thomson was the 'electro-magnetic capacity' of the circuit.

Now, since electric inertia is due to a mutual action between the filaments into which a conductor may be supposed divided, it is manifest that the closer packed they are, the greater their inertia will be, and that to diminish inertia it is only necessary to separate the filaments and spread them out.

The main count of the indictment against ordinary procedure is, that too much attention has been hitherto paid to conducting-power, and too little to inertia. In fact, it is not too much to say that practically nothing but conductivity has been attended to, or thought of, in the erection of lightning-conductors.

Another way of putting the matter is this. A lightning discharge is essentially a varying current: it manifestly rises from zero to a maximum, and then dies away again, all in some extremely small fraction of a second, say, a hundred-thousandth or thereabouts. But that is not all: there is a certain amount of energy to be got rid of, to be dissipated; and it may easily be that a single rush of electricity in one direction does not suffice to dissipate all the stored-up energy of the charged cloud. If the conductor is highly resisting, a single rush is sufficient; but, if it be well-conducting, it is quite insufficient. What happens then? The same as would happen with compressed air or other fluid rushing out of an orifice. If it is a narrow jet, there is a one-directioned blast; but if a wide, free mouth be suddenly opened, the escaping air

overshoots itself by reason of inertia, and springs back again, oscillating to and fro till the stored-up energy is dissipated. Just so is it with an electric discharge through good conductors: it is not a mere one-directioned rush; it is an oscillation, a surging of electricity to and fro, until all the energy is turned into heat.

There is another fact which it behooves us to be aware of. It is one to the importance of which the attention of scientific men has but recently been called. Experimentally it has been discovered by Professor Hughes; theoretically, by Mr. Oliver Heaviside, Lord Rayleigh, and Professor Poynting; for, though the necessary theory is really contained in Clerk Maxwell, it required digging out and displaying. This has now been abundantly done, but the knowledge has scarcely yet penetrated to practical men; indeed, it has not yet been thoroughly assimilated by most physicists. The fact is this. When a current starts in a conductor, it does not start equally all through its section: it begins on the outside, and then gradually though rapidly penetrates to the interior. A steady current flows uniformly through the whole section of a conductor: a variable current does not. It is started first at the surface, and it is stopped first at the surface.

Remembering the rapidly oscillating character of an electric discharge, remembering also the fact that a rising current begins on the outside surface of a conductor, we perceive, that, with a certain rate of alternation, no current will be able to penetrate below the most superficial layer or outer skin of the conductor at all. In the outer skin, of microscopic thickness, electricity will be oscillating to and fro; but the interior of the conductor will remain stolidly inert, and take no part in the action.

Thus we arrive at a curious kind of resistance, caused by inertia in a roundabout fashion, and yet a real resistance, a reduction in the conducting-substance of a rod, so that no portion except that close to the surface can take any part in the conduction of these rapidly alternating currents or discharges. It must naturally be better, therefore, not to make a lightning-conductor of solid rod, but to flatten it out into a thin sheet, or cut it into detached wires. Any plan for increasing surface and spreading it out laterally will be an improvement.

Perhaps it may be as well to guard against one favorite misconception. It has long been known that static charges exist only on the surface of conductors. It has also long been known that ordinary currents flow through the whole section and substance of their conductors. It is now beginning to be known that alternating currents may be sufficiently rapid to traverse only the outer layers of conductors; and this last piece of knowledge is felt to be rather disturbing by those who have been accustomed to dwell upon the behavior of steady currents, and seems like a return to electrostatic notions, and an attempt to lord it over currents by their help. But the first and third facts mentioned above — the behavior of static charges, and the behavior of alternating currents — are two distinct facts, independent of each other; not rigorously independent perhaps, but best considered so for ordinary purposes of explanation.

We have thus mentioned two causes of obstruction met with by rapidly oscillating currents trying to traverse a metal rod. First there is the direct inertia-like effect of self-induction to be added to the resistance proper; the resulting quantity being called by Mr. Heaviside 'impedance,' to distinguish it from resistance proper, for there is a very clear distinction between them. Resistance proper dissipates the energy of a current into heat, according to Joule's law; impedance obstructs the current, but does not dissipate energy. Impedance causes tendency to side-flash; resistance causes a conductor to heat, and perhaps to melt. The greater the resistance of a conductor, the more quickly will the energy of a discharge be dissipated, its oscillations being rapidly damped; the greater the impedance of a conductor, the less able is it to carry off a flash, and neighboring semi-conductors are accordingly exposed to the more danger. Resistance is analogous to friction in machinery; impedance is analogous to freely suspended massive obstruction, in addition to whatever friction there may be. To slowly changing forces, friction is practically the sole obstruction; to rapidly alternating forces, inertia may constitute by far the greater part of the total obstruction, so much the greater part that friction need hardly matter.

This is a fairly accurate popular statement of the direct way in

which self-induction aids resistance proper in obstructing an alternating current. But, in addition to these considerations, there is that other indirect way which we have also mentioned; viz., the fact that conduction of alternating current may be confined to the surface of a rod or wire if the alternations are rapid enough. This cause must plainly increase total impedance; for the total channel open to such a current is virtually throttled, as a water-pipe would be throttled by a central solid core.

But which part of the total impedance does it affect? Does it increase the resistance part, or the inertia part? In other words, does this throttling of a conductor act by dissipation of energy, or by mere massive sluggishness? Plainly, it must act like any other reduction of section: it must increase the resistance, the dissipating-power of a conductor, the heating-power of a current. Hence the resistance of which we have spoken as entering into the total impedance has by no means the same value as it has for steady currents, and as measured by a Wheatstone bridge. It is a quantity greater — possibly much greater — than this; and, in order to calculate its value, we must know not only the sectional area and specific conductivity of the conductor, but also the shape of its section, and the rate of alternation of the current to be conveyed.

We may here note a vigorous controversy, or difference of opinion, between Faraday on the one hand, and Sir W. Snow Harris on the other. Faraday was often consulted about lightning-conductors for lighthouses, and consistently maintained that sectional area was the one thing necessary, weight per linear foot, and that shape was wholly indifferent. Harris, on the contrary, maintained that tube-conductors were just as good as solid rods, and that flattened ribbon was better still. Each is reported to have said that the other knew nothing at all about the matter. Of course, we know that Faraday was thinking of nothing but conduction, and conduction for steady currents. Harris had probably no theoretical reason to give, but was guided either by instinct or by the result of experience. In this particular, Faraday was wrong, and Harris was right.

But, it may be said, have not experiments often been made as to the advantage of tape over rod forms of lightning-conductor, with negative results? Yes, but the point usually attended to is the deflagration of the conductor. Mr. Preece, for instance, with Dr. De la Rue's battery, found ribbon and wire equally easy to deflagrate by the discharge. But we are not examining which form of conductor is least liable to be destroyed by a flash (probably there is not much to choose between one form of section and another, for there is no time for surface cooling): we are examining which form will carry off a charge most easily, and with least liability to side-flash; and here thin ribbon shows distinct advantage over round rod.

It is found that a rod of iron carries off a discharge more satisfactorily than a rod of copper. It would seem as if the poorer conducting qualities of iron enabled the discharge to penetrate deeper, and so to make use of a greater thickness of skin.

But, every one will say, surely iron has far more self-induction than copper. A current going through iron has to magnetize it in concentric cylinders, and this takes time. But experiment declares against this view for the case of Leyden-jar discharges. Iron is experimentally better than copper. It would seem, then, that the flash is too quick to magnetize the iron, or else the current confines itself so entirely to the outer skin that there is nothing to magnetize. A tubular current would magnetize nothing inside it. Somehow or other, the peculiar properties of iron, due to its great magnetic permeability, disappear.

If it turns out to be true that an iron rod does not get magnetized by the passage of a rapidly alternating current, it may be held a natural consequence of the fact that such currents flow mainly in its outer surface, and that such tubular currents have no magnetizing power on any thing inside them.

The magnetizability of iron is no objection to its employment in lightning-conductors. Its inferior conductivity is an advantage in rendering the flash slower, and therefore less explosive. Its high melting-point and cheapness are obvious advantages. It is almost as permanent as copper, at least when galvanized; and it is not likely to be stolen. Professor Lodge regards the use of copper for lightning-conductors as doomed.

It is found that a conductor is more efficient in carrying off a dis-

charge and preventing side-flash, in proportion as its self-induction is lessened; say, by spreading it out into a thin sheet, or cutting it up into a number of wires, or otherwise. But no conductor is able to prevent side-flash altogether, unless it is zigzagged to and fro so as to have practically no self-induction: in that case the side-spark is nearly stopped. But so long as a conductor is straight (and a lightning-conductor must, of course, be straight), so long will there be some tendency to side-flash, however thick it be made. It may be a foot or a yard thick, and yet not stop it. A man touching a lightning-conductor, however well earthed, might perhaps receive a shock sufficient to kill him.

How can this tendency to side-flash be further diminished? To stop a pipe full of water from being burst by a blow given to the water, you will make the pipe elastic. An elastic cushion will ease off the violence of the shock of a water-ram.

Electric inertia was known by the other name of 'self-induction'; electric 'elasticity' is known by the other name of 'capacity.' Increase the capacity — not the thickness or conducting-power, but the electrostatic capacity — of your conductor, and it will be able to carry off more.

The only practicable plan is to expand it over as much surface as possible. A lead roof, for instance, affords an expansion of fair capacity which may be easily utilized; and there should be as little mere rod-projection as possible before some extent of surface begins. Flat sheet for chimneys is better than round rod: it has at least some more capacity, and much less self-induction.

For tall isolated chimneys Professor Lodge would suggest a collar of sheet metal round the top and at intervals all the way down; or a warp of several thin wires instead of a single rod, joined together round the chimney by an occasional woof; or any other plan for increasing capacity and area of surface as much as possible.

As to the liability of things to be struck, several questions suggest themselves: Is a small knob at a low elevation as liable to be struck as a large surface at a higher elevation? Is a badly conducting body as liable to be struck as a well-conducting one? In other popular words, does a good conductor 'attract lightning'?

In answering this question experimentally, one must draw a careful distinction between the case of a flash occurring from an already charged surface, which has strained the air close to bursting-point before any flash occurs, and the case of a flash produced by a rush of electricity into a previously uncharged conductor too hastily for it to prepare any carefully chosen path by induction. The two cases are (1) steady strain, (2) impulsive rush.

Experiment on the liability of things to be struck when the air above them is in a state of steady strain, gradually increased, shows that the flash actually prefers to jump three times as much air to a sharp point, and encounter a megohm resistance, rather than take the short direct path offered by a bigger knob.

By modifying the experiment so as to get an impulsive rush, all bodies are equally liable to be struck if at the same height, and no one is more liable than another: simply the highest is struck if they are at all equally conducting. But by making one bad-conducting, its protective virtue is gone. This is the real objection to a bad earth: it cannot protect well against these sudden rushes.

Sudden rushes are liable to occur: the clouds spark first into one another, and then, as a sort of secondary effort or back kick, into the earth. In these cases the best conducting and highest objects are struck, quite irrespective of any question of points and knobs. Points are no safeguard against these flashes. The point gets struck by a vivid flash. It has no time to give brushes or glows: its special efficacy in preventing discharge exists only in the case of steady action, where the path is pre-arranged by induction. In the case of these sudden rushes, the conditions determining the path of discharge are entirely different. No doubt they have to do with what is called the 'time-constant' of the various conductors.

Electrical oscillations are of considerable interest, and have sundry practical bearings. When a flash strikes a system, the electricity goes rushing and swinging about everywhere for no apparent reason, just as water might surge about in a bath or system of canals into which a mass of rock had just dropped, splashing and overflowing its banks. Just so with electricity. Bell-wires, gas-pipes, roof-gutters, conduct side-flashes in a way most puzzling to the older electricians; and thus gas may get ignited in the most

unexpected places, and passengers in a train may feel a shock because a charge has struck the rails. In powder-magazines it is apparent how dangerous this lawless sparking tendency may be; for even the hinge of a door may furnish opportunity for some trivial spark sufficient to ignite powder. By no means should high rods be stuck up to invite a flash to such places. Build them, or line them, with connected iron, barb them all over the roof, connect them to the deep ground in many places, and but little more can be done.

These electrical oscillations and overflows, which it is easy to set up in a charged conductor, manifestly explain what is known as the 'return-stroke.' This fact—that a discharge from any one point of a conductor may cause such a disturbance and surging as to precipitate a much longer flash from a distant part of it—at once accounts for any 'return-stroke' that has ever been observed.

It is for this reason that it is possible that a tall chimney or other protuberance in one's neighborhood may be a source of mild danger; inasmuch as if it is struck it may be the means of splashing out some more discharges to other smaller prominences, which otherwise were beyond striking distance.

Finally, is it possible for the interior of a thoroughly enclosed metal room to be struck; or, rather, can a small fraction of a lightning-flash find its way into a perfectly enclosed metal cavity, for instance, a spark strong enough to ignite some gun-cotton in a metal-covered magazine which might happen to be struck?

The application of the laboratory experiments to powder-magazines is, that, if any conductor (like a gas-pipe) pass out of the building before being thoroughly connected with its walls, it is possible for a spark to pass from something in the interior of the building to this conductor whenever a flash strikes the building.

The complete and certain protection of buildings from lightning is by no means so easy a matter as the older electricians thought it. In many cases we may be content to fail of absolute security, and be satisfied with the probable safeguard of a common galvanized iron rod or rope. But for tall and important buildings, for isolated chimneys and steeples, and for powder-magazines, where the very best arrangement is desirable, what is one to recommend? Professor Lodge sees nothing better than a number of lengths of common telegraph-wire. He thinks a number of thin wires far preferable to a single thick one; and their capacity must be increased when possible by connecting up large metallic masses, such as lead roofs and the like. But the connection should be thorough, and made at many points, or sparks may result. Balconies, and other prominent and accessible places, should not be connected.

The earth should be deep enough to avoid damage to surface-soil, foundations, and gas and water mains. As to the roof, he would run barbed wire all round its eaves and ridges, so as to expose innumerable points, and the highest parts of the building must be specially protected; but he would run no rods up above the highest point of the building, so as to precipitate flashes which else might not occur, in search for a delusive area of protection which has no existence.

The conductors must not be so thin as to be melted or deflagrated by the flash; but melting is not a very likely occurrence, and, even if it does occur, the house is still protected. The discharge is over by the time the wire has deflagrated. The objection to melting is twofold: first, the red-hot globules of molten metal, which, after all, are not usually very dangerous out of doors; and, second, the trouble of replacing the wire. The few instances ordinarily quoted of damage to lightning-conductors by a flash do not turn out very impressive or alarming when analyzed.

MENTAL SCIENCE.

The Nature of Muscular Sensation.

THE active side of psychic life is represented by movements. The study of the ways and means by which these movements are brought about, are co-ordinated and directed to useful ends, forms one of the most important chapters of physiological psychology; but the elements that enter into conscious motion are so numerous, and so intricately connected, that our knowledge of the process is as yet very defective. It has been well said that the clear and defi-

nite statement of a problem is a long step towards its solution. While recent research has not succeeded in definitely explaining the nature of the sensations connected with movements, it has cleared the problem of many misconceptions which had attached to it, and called attention to those points from which a final solution may be expected. M. Binet has recently brought together the various aspects of the problem, and added thereto an ingenious suggestion towards their further elucidation (*Revue Philosophique*, May, 1888).

The first distinction that M. Binet emphasizes is that between the consciousness of a movement and that of the co-ordination of the muscles necessary to make it. The latter does not enter into the psychic aspect of movement at all. We may be, and usually are, unaware of the simultaneous and orderly contraction of the various muscles necessary to perform a useful act, and yet be perfectly able to do the act. It is the mental conception of the finished act that guides the muscles and gives unity to the movement. Our problem deals only with the methods by which we become aware that our muscles have obeyed the mandate of our will.

The simplest source of such knowledge is that obtained through the eye. We know that a movement has been accomplished, because we see it. Again, in speaking, we know that the muscular mechanism of articulation has acted properly, because we hear the resulting sound. The voices of speaking deaf persons are usually harsh, owing to the lack of the corrective power furnished by the ear. But, even with the eyes closed, we have quite a definite knowledge that the desired movements have been performed. The general sensibility, the feeling of effort as shown in the change of respiration, etc., the dermal sensations produced at joints, and the feeling of the shortening of muscles,—all contribute to the result. We are powerless to analyze the several rôles played by these factors by observing actions in ourselves; but here pathology helps us out of the difficulty, and shows what psychic factor is deranged when a physiological function is lost, as will be touched upon later. Again, this latter class of sensations can learn to control movements which at first require the aid of vision. Walking is a conspicuous example of such. All these factors have the one point in common, that they act after the muscles have contracted. They are due to impressions proceeding inwardly, centripetally, to the brain, and thus informing us what has been done.

The question has been raised, however, whether we have not knowledge of movement centrifugally before the action takes place; whether we have not an outgoing feeling of expended energy suited to the act in question. This view has been supported by many illustrious names, and it has been negatived with equally good authority. The objectors call attention to the fact that there is such a thing as a motor image formed from former sense-impressions, and that this is sufficient to call up the proper mental antecedent upon which the motion ensues. This tells us how much energy to discharge, leaving the rest of the factors to take effect when the action is done.

Pathology calls attention to cases in which the tactile sensibility is destroyed, hoping to draw important conclusions from the interference that this causes with voluntary movement. When such a patient performs a movement, he has only the visual sensory image to guide him; and, if this be taken away by blindfolding him, what will happen? This is the important test; but it is not unambiguous in its interpretation. Most patients will do an action at command with their eyes closed nearly or quite as well as with their eyes opened, the movements in question being those of an anæsthetic limb. They write with the feelingless hand as well as normally. From this observation we can at once conclude that the power of co-ordinating movements, and the consciousness of the motion, are two different things; for these same patients can have their limbs moved for them without their knowing it, thus showing that the centripetal part is interfered with. Another class of patients, however, are reduced, by closing their eyes, to a condition of almost complete motor impotence. In spite of persistent exhortations, they cannot take one hand in the other, touch their forehead, and so on. The upholders of one side of the question emphasize the former result, arguing that the centripetal sensations are not sufficient to direct motion (for here they are lacking), and thus show the necessity of assuming a consciousness of outgoing energy, an

innervation feeling. Their opponents point out that with the loss of sensibility goes the loss of power to move, making an innervation feeling unnecessary. How can these two classes of facts be reconciled and brought under one law?

In answer to this query, M. Binet has a useful suggestion to offer. It has been shown that among hysterical patients with anæsthetic regions a physical or psychic stimulus increases motor power; acts dynamogenetically, as Féré puts it. May not the opening of the eyes act in the same way with some patients, and this re-enforcement be unnecessary with others? In support of this view is the observed fact that in a patient whose right arm was anæsthetic, and who could not move this arm as desired with her eyes closed, this closure of the eyes had a like effect upon the sound left arm. In both cases the movements were slow, inexact, hesitating, more so with the diseased arm. Intermediate cases occur in which the withdrawal of the eye weakens the power of movement without destroying it, thus showing the characteristic individual variations of this re-enforcing power. Moreover, the movements of anæsthetic limbs have, according to M. Binet, been wrongly interpreted. Although such patients are unaware of passive movements, yet these are physiologically registered in their nervous system. This is shown by the fact that a movement thus passively made by guiding the patient's hand will be reproduced by her voluntarily. She does not know what motions have been made with her hand, but her brain-cells reproduce the same motions. We must admit that movements can be voluntary without being conscious. In conclusion, M. Binet gives the opinion that the supposition of a feeling of innervation acting centrifugally is as yet an ungrounded one, and expects much light from future research.

MEMORY OF MOVEMENTS. — In the *Revue Philosophique* for May, Professor Beaunis describes an interesting series of experiments upon the memory of muscular movements. The experiments form part of a more extended research upon the memory of sense-impressions in general, and are concerned with two questions. The first relates to the accuracy with which the length of lines drawn without the aid of the eyes can be reproduced; the second, to the reproduction of angles under similar conditions. A line is drawn, and, after an interval of from five to fifty seconds, the attempt is made to draw a second line equal to the first, making it with a little stroke to distinguish it from the first. Another method was to make a dot move over a distance and make a second dot; in the reproduction to make a small cross move over an equal distance and make a second cross. In another series two lines were drawn making an angle with one another such as <, and the attempt made to draw another broken line with the same angle. In this test right angles were avoided as being too definite an impression. Care was taken not to have the subject know the results, as this would bring about a more or less unconscious rectification of the errors committed. Professor Beaunis describes his memory as a good one, and mentions that the experiments were made in the evening before going to bed, or when awaking in the night or in the morning, when he was undisturbed by outside noises. The strain of fixing the attention on so minute an impression for more than a few seconds he found very considerable, often inducing feelings of *malaise*. From his observations (to be published in detail later) he draws three general conclusions, confessedly of a tentative character. 1. The memory of the movement does not lapse from consciousness gradually. The memory-image does not fade out little by little, but vanishes more or less suddenly. There is here an analogy with the reverse process, that of recalling a forgotten impression. We have a word on the tip of the tongue, when suddenly it looms into consciousness. 2. When it is no longer possible to recall by a purposive effort the line drawn, — when, for example, one does not even remember whether the angle drawn was acute or obtuse, — the hand will none the less, within a given interval, draw a line closely approximating the original. There is an unconscious memory which in turn loses its accuracy. There is thus a phase of conscious memory, succeeded by a period of unconscious (organic) memory, in turn giving way to a more or less complete forgetfulness. 3. There are sudden variations in the accuracy of the reproductions from one moment to another. These follow no definite law, but are doubtless influenced by variations in subjective conditions.

ELECTRICAL SCIENCE.

Some New Primary Batteries.

AMONG the primary batteries that have lately appeared, two — one an English and one a French invention — deserve special notice. The first of these is an invention of M. Weymersch, and is of the ordinary Bunsen type with zinc and carbon electrodes, the improvement consisting in the employment of a new depolarizing fluid, which greatly increases the constancy of the battery. The Bunsen and bichromate cells give a high electro-motive force; but they are not constant under heavy discharge, the electro-motive force falling considerably. The Weymersch battery, according to some tests published in the London *Electrical Review*, has an almost constant electro-motive force for a heavy discharge extending over a considerable period. For instance: from cells with two zinc plates $6\frac{1}{2}$ by $6\frac{3}{8}$ inches, and one carbon plate of the same dimensions, a current of over ten ampères (about 10.3) was taken for thirty-one hours, and at the end of that time the electro-motive force had only fallen a few per cent. The consumption of zinc was only ten per cent more than the theoretical amount, showing that the local action was slight. The inventor proposes to use the battery for the lighting of country houses on a small scale, for torpedo-work, miners' lamps, etc., besides the ordinary uses to which closed-circuit batteries are now put. He calculates that electric lamps aggregating 45-candle power can be supplied for six hours at a cost of eighteen cents per day. Whatever uses it may be put to, it is certain that the tests make an excellent showing.

The other cell, an invention of Mr. O'Keenan of Paris, has been lately described before the New York Electrical Society by Mr. Alfred Shedlock. It is a simple Daniell element, — zinc and copper electrodes in contact with sulphate of zinc and copper respectively. The invention consists in the means employed to keep the strength of the two solutions constant, and a set of cells is arranged to continuously charge storage-batteries from which lamps are supplied. As the electro-motive force of a Daniell cell is about one volt, while that of the Weymersch cell is two volts, twice as much zinc will be consumed in the former as in the latter for the same amount of energy obtained. Mr. Shedlock states that the cost of the zinc and copper sulphate will be at the rate of about one cent per hour for a 12-candle power lamp. If we add the cost of breakage of lamps, interest on investment, depreciation, etc., it will be found that the total cost is at least double this, and lighting in this way would be expensive.

These two batteries are fair types of the improvements that have been recently made in primary cells. Both of them have a field for usefulness, but neither of them can be economically used for lighting or for heavy motor-work.

INCANDESCENT-LAMP EXPERIMENTS. — The following abstract is from the London *Electrician*: "At a recent meeting of the Société Française de Physique, M. Mascart described some interesting experiments which he had carried out with a view of determining how far incandescent lamps might be a source of danger when in the immediate vicinity of inflammable materials. Some 32-candle power incandescent lamps were tightly enveloped in cloth, others in wadding with the gummed surface removed, and others again were placed in the folds of some old stage-scenery. In no case was there any charring or undue heating. An extra thick cotton hood placed over a 32-candle power lamp became charred wherever it was in contact with the globe after ten minutes had elapsed. A 32-candle power lamp which was surrounded by a black silk hood, and then by a black velvet one, set the latter burning gradually in six minutes. In another experiment two lamps were enveloped respectively in black and white wadding from which the gummed surface had *not* been removed; and in two minutes charring commenced, both lamps burst, and the wrappings were set alight. Finally a 300-candle power lamp was laid against some old scenery: in a minute and a half the scenery began to char where the globe touched it, and slowly burnt without flame."

ELECTRICAL RESISTANCE OF COPPER AT LOW TEMPERATURES. — The following note is from *Engineering*: "M. Wroblewski has undertaken to test the truth of Clausius' remark in 1856, that the electrical resistance of chemically pure metals should be

proportional to their absolute temperature; that is to say, if the temperature of a metal could be reduced to absolute zero, its resistance would be annihilated, and its conductivity increase to infinity. M. Wroblewski took advantage of one of the new methods of producing intense cold; namely, that by means of boiling nitrogen at the temperature of its solidification. Wires of copper about $\frac{1}{100}$ of a millimetre in diameter, covered with a double layer of silk, were taken, their conductivity being guaranteed by the makers at ninety-eight per cent of that of pure copper. With this wire M. Wroblewski wound small bobbins having a resistance at ordinary temperatures of about 3 and 20 Siemens units. As the bobbin had to be plunged in liquefied gas, M. Wroblewski began his investigation by studying the electric properties of liquid oxygen and nitrogen. He found that these substances ought to be ranked among the most perfect insulators. The resistances of the bobbins were then measured by the Wheatstone-Kirchhoff method at the temperature of boiling water, ordinary temperature, the temperature of melting ice, the temperature of boiling ethylene at atmospheric pressure ($-103^{\circ}\text{C}.$), the critical temperature of nitrogen ($-146^{\circ}\text{C}.$), the temperature of boiling nitrogen under atmospheric pressure ($-193^{\circ}\text{C}.$), and a temperature nearly that of the solidification of nitrogen ($-200^{\circ}\text{C}.$ to $-202^{\circ}\text{C}.$). The results are embodied in the following table, where t is the temperature, r the resistance in Siemens units, and a the co-efficient of variation of resistance between two consecutive temperatures:—

Bobbin I.			Bobbin II.		
t	r	a	t	r	a
$+100^{\circ}\text{C}.$	5.174	—	$+23.75^{\circ}\text{C}.$	19.251	0.004057
$+21.4$	3.934	0.004365	0	17.559	0.004263
0	3.614	0.004136	-103	9.848	0.004104
-103	2.073	0.00414	-146	6.749	0.004869
-146	1.360	0.004588	-193	2.731	0.007688
-193	0.580	0.004592	-201	1.651	—
-200	0.414	0.006562	—	—	—

These numbers seem to show that the resistance decreases much more quickly than the absolute temperature of the specimens, and approaches *nil* at a temperature not very far from that obtained by evaporating liquid nitrogen in a vacuum.

UNDERGROUND ELECTRIC-LIGHT WIRES.—Several deaths caused by shocks from electric-light wires have called attention to the dangers of the present systems of high-potential distribution, and much has been written in the daily journals about the deadly electric-light wires. The general remedy proposed is to put the wires underground, and in many cities ordinances have been passed directing that all wires shall be buried within a certain time. In the present state of things it will be impossible to obey these ordinances. There are great difficulties and expenses incident to any general system of underground distribution in our large cities. The enormous number of telephone and telegraph lines that must be put in conduits with the electric-light wires—for the scheme embraces the burying of all wires—introduces the factor of disturbance of messages from induction as well as the great difficulty of preventing leakage between the different lines, and from the lines to the ground. And in New York, where this work is being done on a large scale, the commission which directs it is composed of politicians who have no idea of the mechanical and electrical difficulties that must be met and overcome. Again: it is very much a question whether the putting of arc-light wires underground will decrease the danger. The wires have still to be taken to the lamps, and in the branch wires there is the same possibility of accident as before. As the case now stands, then, the putting of electric wires underground will be attended with trouble and expense, possibly with failure. It will not greatly decrease the danger of high-potential lighting, and it will greatly retard its development. At the same time an efficient underground system is much to be desired. It would be as foolish to give up all attempts in this direction as to try to accomplish it at once, without the necessary experience.

The best way would seem to be a gradual putting of the wires under ground, instead of a city directing all the wires to be placed under ground by a certain time. Let them order a certain per cent each year, the localities to be determined by people who know something about the subject. In this way experience will be gained in the cheapest manner, and, if it is found practicable, the end will finally be reached without injury to the companies concerned.

NOTES AND NEWS.

THE *Athenæum* of June 30 announces the death at Brighton of Mr. Edmund Gurney. Mr. Gurney had been subject to obstinate sleeplessness, and had had recourse to opiates. It was an overdose of chloroform that led to his accidental death. Mr. Gurney's best known work was his 'Power of Sound,' a very excellent treatise, and one of permanent value. Of late years he has been oftenest before the public by his contributions to the Proceedings of the Psychic Research Society, of which he was the honorary secretary. He was the chief author of the 'Phantasms of the Living,' and the man to whom, more than to any one else, is due the great interest in psychic studies which this society has aroused. Mr. Gurney had committed himself to the telepathic hypothesis, and was busy to the last in developing that theory. However much one may differ from him in his views regarding the problems of psychic research, all must acknowledge to a great admiration for the courage and industry of the scientist venturing boldly into this psychic 'heart of Africa,' and reporting patiently and systematically his adventures in that mysterious region. His loss is a very serious one to the cause to which he had devoted so many years of his life.

—A. C. McClurg & Co. have just issued the first two volumes of the proposed series of The Great French Writers. The publication of this series has been delayed by the fact that the publishers were disappointed with the translations brought out in England, and therefore undertook the expense of entirely new translations. —A careful and very valuable bibliography of the works of Sir Isaac Newton, with a list of books illustrating his life and works, by G. J. Gray, has just been issued by Messrs. Macmillan and Bowes, Cambridge. The bibliography is divided into ten sections: (1) collected editions of works; (2) the 'Principia'; (3) 'Optics'; (4) 'Fluxions'; (5) 'Arithmetica Universalis'; (6) minor works; (7) theological and miscellaneous works; (8) works edited by Newton; (9) memoirs, etc.; (10) index. —A new edition of the late Professor Humpidge's translation of Dr. Hermann Kolbe's 'Short Text-Book of Inorganic Chemistry' (Longman's) has been issued. The greater part of this edition was prepared by Dr. Humpidge last summer. Being unable, owing to failing health, to complete the task of revision, he asked Prof. D. E. Jones of the University College, Aberystwith, to undertake it, and to see the book through the press. —Mr. Leland will shortly send to the printer his work on 'Americanisms,' which will follow on the 'Dictionary of Slang, Jargon, and Cant,' now in the press. It will contain much folklore in the form of proverbs, songs, and popular phrases, and also the etymology and history of the words, as far as they could be traced. The work will include an account of American dialects, such as Pennsylvania Dutch, Chinook, Creole, and Gumbo. —Nearly the whole edition of Mr. George Seilhamer's 'History of the American Theatre: Before the Revolution,' has been placed; a second volume, 'During the Revolution and After,' is in press, and will be ready in the autumn. Both volumes are published through the Globe Printing-House, Philadelphia. —Kegan Paul, Trench, & Co. have made arrangements for the publication of a set of half-crown books to be entitled 'English Actors: Ten Biographies.' The series will be under the general editorship of Mr. William Archer, and will include lives of Betterton, Cibber, Macklin, Garrick, the Dibbins, the Kembles, Elliston, the Keans, the Matthews, and Macready. Mr. Joseph Knight will deal with Garrick, Mr. R. W. Lowe with Betterton, Mr. E. R. Dibdin with the author of 'Tom Bowling,' and the editor himself with the Keans. The subjects have been selected so as to cover as completely as possible the whole field of English acting from the Restoration to our own time. —Mr. W. J. Linton, one of the leading authorities on wood-engravings of the day, has issued a prospectus, with specimen

pages, of his great work now in press in London, entitled 'Masters of Wood-Engraving.' Ticknor & Co. have been chosen to receive subscriptions for this great work in this country. — William Gibson, jun., New York, has just issued 'Some Details of Water-Works Construction,' by William R. Billings. — The Truth Seeker Company has just published 'The Order of Creation, the Conflict between Genesis and Geology, a Controversy between the Hon. W. E. Gladstone, Prof. Max Müller, Prof. T. H. Huxley, M. Réville, and Mrs. E. Lynn Linton;' 'Rome or Reason, a Memoir of Christian and Extra-Christian Experience,' by Nathaniel Ramsay Waters; 'The Bible of Nature, or, The Principles of Secularism,' by Felix L. Oswald; 'Try-Square, or, The Church of Practical Religion,' by Reporter; and new editions of 'The Secret of the East, or, The Origin of the Christian Religion, and the Significance of its Rise and Decline,' by Oswald, and of Winwood Reade's 'The Martyrdom of Man.' — *Scribner's Magazine* for August will contain another of Prof. N. S. Shaler's notable articles on the surface of the earth, entitled 'Rivers and Valleys,' fully illustrated with views of some of the most picturesque scenery in this country, and dealing in a very practical way with the problems presented by the Mississippi and Ohio River floods.

— A philosophical society has been formed at the University of Vienna under the leadership of Professor Zimmermann and Professor Meynert. Professor Höfler has been elected president. The object of the society is to bring before specialists of all classes general scientific problems having a philosophical import.

— At a recent meeting of the French Physical Society Sir William Thomson was present, and stated, that, according to his determinations, the rate of diffusion of electricity was a hundred and ten times as rapid as that of heat in the best conductors.

— The night movements of the Russian troops have recently been rendered difficult by the number of soldiers attacked with hemeralopia (night-blindness). It is well known that this affection is due generally to a lack of proper food. Meissner saw in Podolia an epidemic of this disease produced during a religious excitement, when bread was the principal article of diet, which disappeared when animal food was again taken.

— The date of meeting of the American Society of Microscopists at Columbus, O., has been changed to Aug. 21 instead of Aug. 14; this on account of change of date for the American Association meeting.

— At the last meeting of the New York Microscopical Society, Mr. George F. Kunz exhibited sand containing monazite, a phosphate of cerium, lanthanum, and didymium, and from 0 per cent to 17 per cent of thoria, from Brindletown, Burke County, N.C., and monazite sand from Caravalhas, Brazil, stating that the demand for these minerals had greatly increased of late, owing to the rare earths zirconia, thoria, glucina, etc., which they contain, and which are now used for the mantle or hood of the new incandescent gas-burner invented by Dr. Carl Auer, now 'Von Welsbach.' This increased consumption has led to a search by the collectors and dealers in minerals in England, Germany, France, Russia, Norway, and Brazil, and more especially in the United States; and so thorough has the search been, that the prices of minerals which were considered rare a short time ago, are now quoted at one-tenth to one-hundredth of former figures. The minerals containing these rare earths are lanthanite, sipylite, tysonite, uranotorite, orangite, thorite, cleveite, monazite, beryl, yttrantalite, alvite, erdmannite, cerite, xenotime, fergusonite, æschynite, allanite, zircon, eudialyte, euxenite, samarskite, gadolinite, and bodenite. Of these, beryl, cerite, monazite, allanite, and zircon have been obtained in large quantities. Sipylite, orangite, and thorite are especially sought for. Monazite has been found at the following localities: Villeneuve, Ottawa County, Canada (a crystal of fourteen pounds and a half); Alexander County, N.C., at Millholland's Mill; Amelia County, Va. (in twenty-pound lump); Norwich, Conn.; Ural Mountains; Mount Sorel (var. turnerite), Tavetch (var. turnerite), and Binnenthal, Switzerland; River Sanarka, Southern Ural; Arendal, Norway. At these localities the occurrence is of mineralogical interest only. At the North Carolina, Georgia, and Brazilian

localities it can be obtained in quantity for commercial use. In the North Carolina gold gravels of Rutherford, Polk, Burke, McDowell, and Mecklenburg Counties, monazite is found in considerable quantities in small brown or greenish or yellowish brown monoclinic crystals associated with chromite, garnet, zircon, anatase, corundum, menaccanite, xenotime, fergusonite, epidote, columbite, samarskite, and other minerals. With these associations have been found several of the North Carolina diamonds; and at the Glade Mine, Georgia, diamonds have been found with the monazite, which exists in some abundance also. These localities will furnish tons of monazite within the next twelve months. The Brazilian monazite is found at Caravalhas, Bahia, where its existence was made known about eight years ago by Dr. Orville A. Derby, geologist of Brazil. It occurs in large quantities as a beach-sand, almost free from other minerals, as if concentrated. As it occurs on the coast, it can easily be shipped to any point where it is wanted, and a number of tons have been sent to the United States. The best North Carolina zircon locality is on the old Meredith Freeman estate, Green River, Henderson County, N.C., which was leased for twenty-five years in the hands of Gen. T. L. Clingman of that State, who, as early as 1869, mined one thousand pounds of it, and during that whole period never lost faith in the incandescent properties of zirconia; but when the time of its adoption actually came, through some legal difficulties the general had forfeited his leases, and hence failed to reap his reward. In Henderson County, N.C., and in Anderson County, S.C., zircon is found in large quantities loose in the soil, as the result of the decomposition of a felspathic rock. The crystals are generally remarkable for their perfection, being distinctive of each locality, weighing occasionally several ounces. The recent demand has also brought to light the existence of enormous quantities of zircon in the Ural Mountains and in Norway. Although in Canada, in Renfrew and adjoining counties, enormous crystals have been found up to fifteen pounds each, yet they are so isolated, that it would be impossible to obtain a supply there. The new demand has brought together more than twenty-five tons of zircon, ten tons of monazite, six tons of cerite, thousands of pounds of samarskite, and tons of allanite and other minerals. As a consequence, zircon is now offered at less than ten cents a pound, monazite at twenty-five cents, and samarskite at fifty cents.

— While Australia is complaining of rabbits, Russia is invaded by the marmots. In certain provinces in Odessa it has been proposed to try Pasteur's system of inoculating them with chicken-cholera, but the administrative authorities have not given the scheme their approval.

LETTERS TO THE EDITOR.

Negro Dialect.

A WRITER in the *North American Review* for June, 1888, mentions certain words in use among the negroes of the Southern States, and inquires after their origin. The words are *buccra* ('white man'), *goober* ('peanut'), *brottus* (used in Georgia in requests for small presents, as, 'What are you going to give for *brottus*?'), and *lagniappe* (used in New Orleans in somewhat the same sense as *brottus*).

With regard to *lagniappe*, there seems to be no good cause to dispute the derivation from the Spanish given by Mr. George W. Cable. He says, "The pleasant institution of *ñapa*, the petty gratuity added by the retailer to any thing bought, grew the pleasanter, drawn out into the Gallicized *lagnap*" (*The Creoles of Louisiana*, London, 1885, p. 114). The derivation of *brottus* may be similar to that of *lagniappe*, from the English perhaps, but one cannot speak with certainty.

The word *goober* ('peanut') is, I think, of African origin. In Hausa (a West African tongue), *guja* is 'ground-nut.' The following passage, however, from a rare and interesting work of the beginning of the eighteenth century, goes far, I hope, to settle the matter.

In the English translation of Bosman's account of Guinea we read, "Here is also another sort called *Gobbe-Gobbes*, which grow

two together in a Cod under the Earth, and shoot out a small Leaf above the surface of the Earth; these are the worst of all the sorts of Beans, and yet they are eaten by several" (*A New and Accurate Description of the Coast of Guinea, etc. . . . Written originally in Dutch by Wm. Bosman. . . . And now faithfully done into English*, London, 1705, p. 301). From *gobbe* to *goober* is not far, and the object named is the same, beyond a doubt. The origin of *buccra* ('white man') is not clear; but in Hausa, *butra* means 'master.' I would appeal to those acquainted with the negro dialects to publish short lists of words, such as those dealt with, which will be of great value in determining the ethnological relations of the ancestors of the present negro population of the United States.

A. F. CHAMBERLAIN.

Toronto, July 2.

Object-Lessons in Oriental Faiths and Myths.

A REMARKABLE collection will soon be opened to the world in Paris. The municipality has given a plot of ground that cost two hundred thousand dollars on the Avenue d'Jéna, and a large and beautiful stone structure has been erected on it by the state, under a law passed while the present president, Carnot, was finance minister. This law secures over three hundred thousand dollars for the erection of a building, and endows the establishment thus formed with a perpetual annuity of nine thousand dollars for purposes of maintenance. The glass cases for the collection are partly placed and filled, and the public will be admitted in a few months.

The collection is primarily intended to teach the history of the development, and the characteristics, of the Oriental religions. The importance of this study strikes us forcibly when we reflect that these forms of faith still deeply influence the daily lives of more than one-half of the human race, and that they have solaced and guided tens of thousands of millions of our fellow-creatures.

The originator and collector of this unique series of objects is the well-known student of Oriental languages, M. Etienne Emile Guimet, the son of a wealthy citizen of Lyons. He has spent more than twenty years of an active scholarly life in voyages to, and residences in, China, Japan, and other Asiatic lands, and has devoted several millions of francs from his large fortune to this work of public instruction. In his native town he is also known for his persistent and munificent efforts to secure high-class musical entertainments for the people; and, if his efforts are measured by the exquisite congregational singing that I recently heard in one of the Lyons churches, his efforts have been signally successful.

Yesterday I spent the morning with M. Guimet, examining the collections already in place. We first passed through two long halls, carefully arranged, and lighted from both sides with high windows, — halls, let me say, that would form admirable models for the future architects of the Metropolitan Museum. Here we found two comprehensive collections of pottery, — one from China and one from Japan, — each arranged geographically and historically, beginning, in the case of Japan, with the southern provinces, and ending with the northern. These most valuable gifts of M. Guimet, however, do not belong to my present subject.

From these halls we entered the lofty library, where are already placed twelve thousand volumes of books and manuscripts containing official statements in the original tongues of the dogmas, creeds, and myths of all the important Oriental forms of belief. Thence we passed to an extensive hall, in which the Japanese religions are illustrated and classed.

Illustrations of the earliest form of the Shinto nature-worship begin the extensive series. First we have the round metal mirrors resting upon mimic waves of sculptured wood, that stood high in the temple to catch the earliest rays of the rising sun; then figures of the simply clad priests; then the implements for making the primitive offering of fire and incense to the unembodied god. In order of time follow the paraphernalia of the Buddhist priests, who, crossing from Corea, brought with them their gorgeous ritual and imposed it upon the nation. Then we have innumerable figures of Buddha and attendant deities in gold, silver, bronze, lacquer, and clay, representing the ideas of the important contending sects into which Buddhism was soon divided through the agency of sacerdotal ingenuity.

In the middle of the hall, under the skylight, is a representation

of the interior of a Japanese temple of the first class, with original images of all the gods before whom worship is usually conducted. Here we may see, how, in the imagination of the Japanese (the sacred Buddha sends forth four great agencies that save men through persuasion), they are shown to the popular eye in the form of golden figures of prophets in silken robes; and also how four other emanations from Buddha, symbolical of darkness, compel men to do right through fear, shown as carved images of black devils with gnashing teeth.

Beyond this group are series of cases containing thousands of objects explaining Japanese myths, lives of saints, and the stories told about their sacred people and places. Another extensive hall contains a series of figures and other objects elucidating the forms of belief, the myths, and the folk-lore of China. In another the Greek mythology is systematized, in another the Roman, in another the Egyptian. One of the most interesting cases is that containing original images from many places in the countries and islands bordered by the Mediterranean, showing the various steps by which the Egyptian gods were accepted and adopted under new names successively by the Greeks and by the Romans. The rooms containing the collections from the western lands are as yet but partly arranged. Enough can be seen, however, to show how important and complete the series of objects must be, — enough to show that the world furnishes no other collection of the kind nearly so large, or so well prepared for the serious study of the development of Oriental and ancient civilization.

M. Guimet declared that he had no theory to support in forming his museum. He has excluded the Christian and the Hebrew forms of worship from his scientific treatment, and has confined himself to those lands where religion dawned upon mankind, and where great faiths that dominated extensive territories were developed. He simply presented the authentic documents and the authorized symbols for the use of the scholar.

L.

Paris, June 20.

An Army of Myriopods.

I am in receipt of a letter, bearing the date July 6, 1888, from Mr. W. H. Cleaver, East Bethlehem, Penn., in which he states that the 'worms,' specimens of which he sends, are at the present time very abundant in his neighborhood.

To quote from the letter, "they are travelling eastward in countless millions. They travel at night or in the cool of the morning and evening. They camp during the day by getting under sods, boards, stones, or any thing to protect them from the heat of the sun. In some places during the day they are piled up in great numbers. They do not seem to destroy any thing on their journey, but go harmlessly along. Fowls will not eat them, and birds do not appear to molest them."

The specimens which accompany the letter are, I think, the common *Polydesmus erythropygus*. In the absence of any complete systematic work on the *Myriopoda*, I am not able to identify the species with absolute certainty. The species is very common in this vicinity, but I have never before heard of its occurrence in such numbers as reported by Mr. Cleaver.

EDWIN LINTON.

Washington and Jefferson College, Washington, Penn., July 7.

The Old South Work.

YOU credit me, in your last number, with instituting the lectures in Chicago, like our 'Old South' lectures here in Boston. That credit does not belong to me. I have for some years been concerned in the direction of the 'Old South Work' in Boston, which is so liberally sustained by Mrs. Hemenway; and recently I gave the opening lecture in the Chicago course. But the credit of instituting the work in Chicago belongs to Mr. H. H. Belfield, the principal of the Manual-Training School in that city. He has labored with rare devotion and energy to establish these 'Old South' lectures in Chicago, and his success has certainly been very great. If every city had a man of equal patriotism and equal practical power, we should see much done to bring our young people up to higher ideas of citizenship, and to elevate the general political tone throughout the country.

EDWIN D. MEAD.

Boston, July 9.